MYCOTAXON

Volume 107, pp. 431–440 *January–March 2009*

Two new boreal species of *Tricholoma* from Fennoscandia

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Abstract— Two new species of *Tricholoma* are described from the boreal part of Fennoscandia. *Tricholoma guldeniae* is based on *T. luridum* sensu Nordic auct. Morphologically it belongs to the *T. sejunctum* group, but it is characterised by a greyish yellow cap, and large, irregular spores. *Tricholoma olivaceotinctum* is based on *T. squarrulosum* sensu Nordic auct. It is closely related to *T. squarrulosum,* but differs by growing with conifers and by having a distinct greenish-olive tint on the cap. Based on our present knowledge, these locally rather frequent species are endemic to North Europe (including Scotland). The identity of both species is supported by information from ITS sequencing. Descriptions, keys, and information on distribution and ecology of the new described species are given in the present paper.

Key words—*Agaricales*, boreal forest

Introduction

Even though the euagaric genus *Tricholoma* is well known by most European mycologists, it still contains several species groups that are rather poorly resolved with regard to taxonomy and nomenclature. One reason for this is the persistence of different mycological traditions in various parts of Europe. In Scandinavia, the mycological tradition of Elias Fries and co-workers in the 19th century was continued into the 20th century by Nordic mycologists including A. Blytt, P.A. Karsten, J.E. Lange, and S. Lundell, works that still provide an important basis for contemporary Nordic taxonomy. Due to their status as sanctioning works in the Vienna Code (McNeill et al. 2006), Systema Mycologicum and Elenchus Fungorum published by Elias Fries (1821-32) play a crucial role for the interpretation of classical fungal epithets. Fries applied many epithets proposed by authors from central and western (i.e., non-boreal) Europe including Persoon, Schaeffer, and Bulliard. In many cases

Fries interpreted these names in agreement with their original meaning, but in others, the Friesian interpretation is not consistent with the original intention. This is not least the case for a number of boreal taxa for which Fries wrongly applied epithets based on fungi described from central and western Europe. In many cases Nordic mycologists have persisted in interpreting such epithets in agreement with Fries, while mycologists from other parts of Europe have used them for more southern species in agreement with their original authors. As a consequence many classical fungal epithets are interpreted differently in various parts of Europe. Studies of type specimens and specimens from different parts of Europe are necessary in the solution of such conflicting interpretations. The present work is a small contribution in this process suggesting new names for two northern *Tricholoma* species that have been well known but wrongly named by Nordic mycologists for many decades. The study is based on studies of fresh and herbarium material of *Tricholoma* species from several countries across Europe to secure an identical use of epithets across the continent.

Materials and methods

Fresh specimens of *Tricholoma* species have been studied in Denmark, Finland, France, Great Britain, Italy, Norway, Slovakia, Slovenia, Sweden, and Switzerland. In addition herbarium material has been obtained from several herbaria across Europe and USA (BG, C, E, GB, H, Kuopio, LUG, M, NYS, O, OULU, TRH, Tromsø, TURA, TUR, S, UPS, A. Riva's private herb. and M. Bon's private herb.). All relevant available type collections have been studied.

Descriptions of both fresh and dried collections follow the terminology used in Bas et al. (1988). Colour descriptions follow Kornerup & Wanscher (1969).

Of all critical collections at least 20 spores were measured at 1000–2000× magnification; other microscopical characters were studied following less strict rules. Spores were measured mostly from mounts of the hymenium. Dry material was mounted in 3–5 % KOH. For each species the number of spores measured is indicated in square brackets followed by the number of collections from which these measurements have been taken. Spore dimensions are indicated as a range with the extremes in brackets. The length/width ratio (Q) is also given as a range. The ranges of the averages for both dimensions and the Q value are also mentioned.

ITS sequence data of the holotypes of *Tricholoma guldeniae* and *Tricholoma olivaceotinctum* were produced for this study and the sequence data sent to GenBank. DNA was extracted, amplified, and sequenced according to the methods in Frøslev et al. (2005). ITS data were compared to sequence data available from sequence data from all *Tricholoma* specimens available on GenBank as well as to unpublished sequences by the present authors with simple neighbour-joining and parsimony methods (data not shown).

Tricholoma guldeniae Mort. Christ., **sp. nov.**

MycoBank MB 512781; GenBank FJ544860

Misapplied: *Tricholoma luridum* (Schaeff.) P. Kumm., sensu Nordic auct. (Gulden 1969: p. 70, Salo et al. 2005: p 769.)

Pileus 50–80(–100) mm, campanulatus us que ad convexus cum umbone, cinereo-luteus, sericeus us que ad subsquamulosus. Lamellae emarginatae, albidae, acie saepe lutea. Stipes 40–100 × 9–20 mm, albidus, subfibrillosus. Caro alba, odore et sapore farinoso. Sporae 7.5–10.5 × 6.0–7.8 µm, Q = 1.0–1.6, in magnitudine et forma heterogenea, laeve, hyalinae, non-amyloideae. Basidia 37–45 × 8.5–11.0 µm, 1, 2, 3, 4-sporia. Pileipellis cutiformis. Fibulae absentes. In sylvis coniferarum.

Holotypus: *Norway, Akershus, Nannestad, Hornsjøen, leg. G. Gulden, 08.09.1995 (n° MC95-103) in herbario C (Copenhagen).*

Etymology: *guldeniae* (Latin), in honour of Gro Gulden.

Pileus 50–80(–100) mm, at first campanulate or conical with deflexed margin, later convex to plano-convex with a small, sometimes pointed umbo, finally applanate with straight or reflexed margin, which is sometimes radially splitting, innately fibrillose to finely squamulose, with grey-brown or greyish yellow fibrils or squamules on a pale yellowish or whitish background, darkest in centre, dry to rarely faintly viscid. Lamellae adnate to emarginate, medium to rather distant, whitish or with a slight greyish or yellowish tinge, edge serrulate, sometimes yellowish. Stipe 40–100 × 9–20 cm, cylindrical or gradually tapering towards base or apex, whitish or pale yellowish, smooth or innately fibrillose, but often shining when dry. Context whitish or slightly watery grey or yellowish in pileus or stipe; smell weakly farinaceous; taste farinaceous, mild.

Spores [1298, 67] (6.8–)7.5–10.5(–11.5) × (4.8–)6.0–7.8(–8.5) µm, average: 7.4–9.3 × 5.9–7.4 µm, Q= 1.0–1.6, average: 1.1–1.4, very heterogeneous in size and shape, some large and subglobose, others ellipsoid, smooth, hyaline and non-amyloid. Basidia 37–45 × 8.5–11.0 µm, 1-, 2,- 3- or 4-spored, normally all types occur in a single basidiocarp. Pileipellis a cutis of parallel hyphae with rather short segments, hyphae approximately 15–30 × 5–8 µm, rather strongly incrusted with brownish or yellowish pigment. Subpellis of inflated hyphae 20–50 × 6–15 µm, only weakly incrusted. Clamp connections absent.

Distribution and Ecology — *Tricholoma guldeniae* is most frequent along the west coast of Norway and in coastal areas of SE Norway. It is one of the most frequent tricholomas in the natural spruce forest enclave of the Voss district, W Norway (T.E. Brandrud pers. obs.). In this region, it also occurs widespread in spruce forest plantations outside the natural distribution of spruce, e.g. in the Bergen area. In Sweden it is rather frequent only in the southwestern parts and only a few collections are known from Finland. Outside Fennoscandia it is at present known only from Scotland.

The species is most frequently collected in moist or submesic ± calcareous *Picea* forests. 63 percent of the 27 collections with ecological notes belong to this type of habitat. The species is also recorded from more acidic habitats. A few collections are from forests with *Pinus*, *Quercus*, *Betula*, *Populus,* or *Corylus* often in mixed stands, but it is unclear whether the species forms mycorrhiza with any of these hosts. The species seems to be one of few strongly oceanic spruce forest associates.

Selected collections: **Norway:** Akershus, Nannestad, Hornsjøen, 08.09.1995, G. Gulden, (holotype, M. Christensen 95-103), (herb. C); Buskerud, Hole, Krokskogen, 09.09.1957, Sundbye, Sverre G., (herb. O); Hedmark, Kongsvinger, Kongsvingertraktene, 22.09.1967, G. Ånerud, (herb. O); Hordaland, Bergen, Stend, 11.09.1966, K. Hvoslef, (herb. O); Møre og Romsdal, Molde, Hovdenakken, 03.09.1982, J. A. Vaagsæter, (herb. O); Nord-Tr¢ndelag, Namsos, Mellom Kleppen og Høknesmyrene, 08.10.1967, J. Stordal, (JS 12549), (herb. O); Nordland, Rana, Hammernes, 08.09.1976, H. Folkmar, (G. Gulden 46a/76), (herb. O); Oppland, Jevnaker, NW of Mylla, 28.09.1969, P. Wassum, (herb. O); Oslo county, Oslo, Høybråten,, 08.08.1963, G. Gulden, (GG 130), (herb. O); Rogaland, Sandnes, Lutsi, 16.08.1953, J. Stordal, (JS 8872), (herb. O); Sør-Tr¢ndelag, Trondheim, Elsterparken, 29.08.1951, Eriksson, (JS 6569), (herb. O); Vest-Agder, Lyngdal, Lyngdal, 10.09.1959, J. Stordal, (herb. O); Vestfold, Våle, Hengsrud, 26.09.1981, Course, (herb. O); Østfold, Fredrikstad, Ulfeng, 02.09.1973, W. Ramm, (herb. O) - **Sweden:** Göteborg, Botaniska Trädgården, Arboretet, 29.08.1977, S. Jacobsson, (SJ 77199), (herb. S); Skåne, Vånga, Skärsnäs, 23.09.1982, L. Örstadius, (LÖ 325-82), (herb. L. Örstadius); Västmanland, Guldsmedshyttan, vid Leja gård, 11.09.1994, H. Kaufmann, (HK 94035 A), (herb. S) - **Finland:** Uusimaa, Pornainen, Laukkoski, Sopenmetsä, vanha kuusimetsä, 05.10.1991, P. Höijer, (herb. H); Varsinais-Suomi, Koski T. l., Hongisto, 29.09.1991, P. Heinonen, (PH 299-91), (herb. TUR) - **Great Britain — Scotland**: Loch Habor S of Pass of Gencae E of Allt Lairis Eilde, 20.09.1993, J. Schreurs, (Schreurs 796), (herb. L).

Discussion — *Tricholoma guldeniae* can be distinguished from other species resembling *T. sejunctum* by the large but heterogeneously sized spores and the greyish yellow, non-viscid pileus. According to our ITS analysis (results not shown), *T. guldeniae* belongs to the core clade of *Tricholoma* and seems most closely related to *T. columbetta*, *T. equestre* and *T. umbonatum*.

Gulden (1969) applied the name *Tricholoma luridum* to the species. *Tricholoma luridum* was, however originally depicted and described by Schaeffer (1762, plate 69) and later named as *Agaricus luridus* in Schaeffer (1774). The description was accompanied by a painting, which shows a cluster of fungi with convex, greyish yellow pilei and greyish lamellae. The plate seems close to the interpretation in the tradition maintained in more southern parts of Europe (Kühner & Romagnesi 1953, Riva 1998, Bon 1991; see further comments on this taxon below).

Fries did refer to *Agaricus luridus* Schaeffer in his sanctioning work (Fries 1821, page 40) but also to *Agaricus luridus* Persoon (Fries 1821, page 65). The latter was later combined into *Lactarius* by Gray (1821), and is still accepted as

a good *Lactarius* species (e.g. Heilmann-Clausen et al. 1998). Being published in 1801 *Agaricus luridus* Persoon is, however, a later homonym of *Agaricus luridus* Schaeffer, and hence an illegitimate name. Thus, *Lactarius luridus* needs to be renamed, unless another valid name can be traced for this taxon. In his later publications (Fries 1838, 1874) Fries placed *Agaricus luridus* Schaeffer in his section *Tricholoma*. However, Fries's description indicates that he confused this taxon with his own interpretation of *Agaricus sejunctus* (which differs from the original *Agaricus sejunctus* in the sense of Sowerby), which we consider a synonym to *Tricholoma arvernense* Bon (e.g. Christensen & Heilmann-Clausen 2008). Fries never mentioned any microscopical details, but an unpublished painting of *Agaricus luridus* at the Natural History Museum in Stockholm made under supervision of Fries fits very well with *T. arvernense*. Karsten (1899), who followed the tradition of Fries, also used the name *T. luridum* for *T. arvernense*. His description and three collections in the herbarium in Helsinki support this. The first unambiguous description of our *T. guldeniae* thus seems to be that presented by Gulden (1969, sub nom. *T. luridum*).

According to the protologue of Schaeffer (1774), and the prevailing interpretation in Europe south of Fennoscandia, the true *T. luridum* is a compact and rather small *Tricholoma* species with a convex, dark grey pileus almost lacking yellow greenish tinges, distant, thick, grey or greyish lamellae, and large, but uniform ellipsoid spores (7.8–10.3 × 4.8–7.3, average 8.6–9.6 × 6.2–6.6, Q=1.3–1.6, average 1.4–1.5) from 4-spored basidia only (description based on collections from France, Switzerland and Austria). *Tricholoma luridum* is widespread in Europe south of Fennoscandia in both coniferous and deciduous forests. Bon (1984) mentions *Abies* and *Picea* as the primary hosts while Riva (1998) mentions coniferous and mixed forests with *Fagus* as habitat. The species has never been recorded from Fennoscandia, but could be expected to occur in the southernmost parts, as there are scattered records of the species through Germany.

Key to the species resembling *T. guldeniae* in northern Europe:

1. Spores small (4–6 × 3–5 µm), most hyphae in pileipellis with clamp connections, pileus in mature basidiocarps straw-yellow or brownish yellow without greenish colours ..... *T. arvernense*
- Spores longer (> 6 µm), hyphae in pileipellis without clamp connections, but basal clamp connections at the basidia sometimes present, pileus with or without greenish colours 2
2. Stipe more or less squarrulose, colour of pileus olive-green, olive-brown or golden-brown 3
- Stipe glabrous or slightly fibrillose, colour of pileus yellow, greenish or greyish 4

3. Basidiocarps slender, pileus olive-green, olive-brown or blackish olive, spores subglobose (7–8.5 × 6–7 µm), basidia without clamps . . . . . *T. fucatum*
- Basidiocarps stout, pileus golden brown, spores ellipsoid (6–7 × 4.5–5 µm), basidia sometimes with clamps. . . . . *T. joachimii*

4. At least some spores very large (length > 8.5 µm), pileus pale greyish green or dark olive green. 5
- All spores smaller than 8.5 µm, pileus with yellow green colours, with or without dark blackish innate fibrils 6

5 Spores homogeneous in size (8–10 × 5–7 µm), basidia 4 spored, pileus often viscid, lamellae greyish to grey, distant, under deciduous and coniferous hosts in Europe south of Fennoscandia . . . . . *T. luridum*
- Spores heterogeneous in size and shape, but at least some spores very large (7–11 × 6–8.5 µm), basidia 1, 2, 3 or 4 spored, pileus normally non-viscid, often with pale greyish innate fibrils, lamellae whitish or pale greyish, under conifers in Fennoscandia and Scotland . . . . . *T. guldeniae*

6. In deciduous forest, pileus greenish or yellowish, (spores 6–7.5 × 5–6 µm) . . . . . *T. sejunctum*
- In coniferous forest, pileus greyish yellow-green or brownish yellow with innate blackish fibrils, (spores 6–8.5 × 5–7 µm). . . . . *T. viridilutescens*

Tricholoma olivaceotinctum Heilm.-Claus. & Mort. Christ., **sp. nov.**

MycoBank MB 512781 GenBank FJ544861

Misapplied: *Tricholoma squarrulosum* Bres., sensu Nordic auct. (Ryman & Holmåsen 1984, Hansen & Knudsen 1992, Salo et al. 2005)

Pileus 38–75(–120) mm latus, hemisphaericus usque ad convexus cum umbone, fumosus-viridifuscus squamulosus. Lamellae emarginatae, albidae-cinereae. Stipes 30–80 × 6–20 mm, albidus-cinereus, subfibrillosus-subsquamulosus. Caro alba. Odor dulcidulus et farinosus. Sapor farinosus. Sporae 4.0–6.7 × 2.8–4.9 µm, Q=1.1–1.8, laeves, hyalinae, non-amyloideae. Basidia 18–27 × 5–7 µm, 4-sporigera. Pileipellis trichodermis. Fibulae absentes. In sylvis coniferarum.

Holotypus: *Sweden, Jämtland, 5 km SE of Brunflo, leg. M. Christensen 04.09.1997, (n° MC97-103) in herbario C (Copenhagen).*

Etymology: *olivaceotinctum* (Latin) = with olivaceous colours, referring to the colours at the cap margin.

Pileus 38–75(–120) mm, at first convex, hemispherical or obtusely conical, expanding to broadly applanate or even planoconcave, typically retaining a small umbo, densely covered by small, very distinct, dark olivaceous brown to black, recurved scales on a cream to olivaceous grey background, olivaceous colours normally distinct, especially in young specimens, which may be almost sulphur yellow at the edge. The scales are often forming a confluent dark spot in the centre. Lamellae emarginate, rather narrow to normal, normal to rather dense, almost white to pale greyish, often with a faint olivaceous tinge, sometimes with small black spots. Stipe 30–80(–150) × 6–20(–30) mm,

cylindrical, mostly distinctly swollen at base, white to pale brownish grey or pale olivaceous grey, smooth or slightly greyish fibrous to scaly at apex. Context soft, brittle to rather elastic, often hollow in stem, whitish to pale olivaceous grey, sometimes becoming darker upon exposure. Smell weak, but distinctly spicy, sweetish, reminding of honey often intermixed with pepperish components, after cutting faintly to strongly farinaceous. Taste mild to slightly bitter, distinctly farinaceous.

Spores hyaline [170, 8], 4.0–6.7 × 2.8–4.9 µm, average 5.0–5.7 × 3.5–4.1 µm, subglobose to oblong, Q = 1.1–1.8, average = 1.36–1.54. Basidia 18–27 × 5–7 µm, 4-spored. Pileipellis a cutis of ± parallel hyphae breaking up in curved, trichoderm scales, hyphae (13–)17–50(–75) × 7.5–15(–22) µm, partly incrusted with brownish or blackish pigment. Clamp connections absent.

Distribution and Ecology — *Tricholoma olivaceotinctum* is confined to moist *Picea* stands mostly on somewhat calcareous soils. It is widely distributed in Fennoscandia, but is generally rare, with most records from the lime-rich soils in the provinces of Medelpad and Jämtland in central Sweden. According to Salo et al. (2005, sub nom. *T. squarrulosum*) it is more or less restricted to old-grown stands in Finland, which agrees with our personal experience from Norway and Sweden. It seems to be a truly boreal taxon, restricted to the natural *Picea* forest zone in central and northern Fennoscandia. The species is red-listed in Finland, Norway, and Sweden (Gärdenfors 2005; Salo et al. 2005; Kålås et al. 2006; sub nom. *T. squarrulosum*). We know of no collections south of central Sweden and southern Norway and consider it unlikely that it should occur together with the true *T. squarrulosum* in any kind of habitats in Europe.

Collections examined: **Norway,** Oppland, Nordre Land, Øst-Torpa, Røste N. of Kinn Church, 12.09.1984, leg. B. Wasstorp (S); **Sweden,** Jämtland, Brunflo, Tandsbyn, 02.09.1997, leg. J. Heilmann-Clausen, JHC97-131 (C); Jämtland, 5 km SE of Brunflo, 04.09.1997, leg. M. Christensen MC97-103 (C); Jämtland, Fillstabäcken, 02.09.1997, leg. K. Olofsson, JHC97-145 (C); Jämtland, parishes of Mörsil & Mattmar, 23.08.1979, leg. Nils Hakelier, (UPS); Jämtland, Mattmar parish., Storbodarna, 16.08.1984, leg. S. Ryman (UPS); ibid 27.08.1978, leg. N. Hakelier (S); Jämtland, Mattmar, ca. 1 km SO of Mattmars station, 29.08.1978, leg. N. Hakelier (S); Jämtland, Mörsil, Ris, 30.08.1978, leg. N. Hakelier, (S); Jämtland, Mörsil, Sällsjö, 19.08.1978, leg N. Hakelier, (S), ibid. 01.09.1981, leg. O. Persson & L. Lundberg, (UPS); ibid. 15.08.1984, Å. Strid 17341 (S); Jämtland, Alsen, between Glösa and Hallängden, 24.08.1978, leg. N. Hakelier, (S); Lappland, Åsele Lappmark, Dorotea, N. of V. Ormsjö, leg. K. Jaederfelt, 21.08.1990, (S); Lappland, Åsele Lappmark, Risbäck, S slope of Arksjöberget, 29.VIII.1993, leg. K. Jaederfelt (S); Medelpad, Borgsjö, Bergåsen, 13.09.1995, leg. M. Christensen, MC95-135 (C); ibid, 13.09.1995, leg. J. Heilmann-Clausen, JHC95-050 (C); Medelpad, Borgsjö, Julåsen, 15.09.1997, leg. J. Heilmann-Clausen, JHC95-070 and 071 (C); Medelpad, Borgsjö, 1 km N of Annalund, 01.09.1993, leg. B. Hagman (S); Norrbotten, Piteå parish, Sjulsmark, Bastabäcken. 14.09.1985, leg. B. Öster (S); Uppland, Lagga parish, 1 km SW of Lingsberg, 14.V.1977, leg. N. Lundqvist (UPS).

Discussion — *Tricholoma olivaceotinctum* has long been known under the name *T. squarrulosum* in Fennoscandia (e.g. Ryman & Holmåsen 1984, Gulden 1992, Salo et al. 2005). This is understandable since both the present species and the true *T. squarrulosum* share important macroscopical characters, i.e. the blackish squamulose pileus in combination with a pale greyish to dark brownish grey stipe. After field studies in different parts of Europe, we realised that the species occurring in boreal coniferous forests in Scandinavia clearly differs morphologically from the species occurring mainly in broadleaved forests from southern Scandinavia to the Mediterranean zone. The separation is well supported by ITS sequence patterns (results not shown).

Tricholoma squarrulosum was originally described by Bresadola (1892) from Trento in Italy, and in southern Europe the name is consistently used for a rather common *Tricholoma* species with blackish scales on the cap and stem, large spores and an occurrence mainly in thermophilous *Quercus* forests (e.g. Bon 1984, 1991, Riva 1988). We see no reasons to doubt this interpretation of the original concept of Bresadola. We have studied the type of *T. squarrulosum*, which is in fairly good condition. It is macroscopically similar to our own dried specimens of this species and the spores are long (6.5–8.5 × 3.5–4.5 µm), in agreement with our own material.

Tricholoma squarrulosum occurs also in thermophilous deciduous forests in central and northwest Europe, north to Denmark, south Sweden and England, where it is often referred to as *T. atrosquamosum* (e.g. Noordeloos & Christensen 1999). We consider this interpretation of *T. atrosquamosum* to be inconsistent with the original intention of the epithet. According to the protologue of Chevalier (1837), *Agaricus atrosquamosus* occurs in mossy mountainous forests ("inter muscos in sylvis montosis Hercyniae") and the iconotype (no type specimen has been found) depicts a *Tricholoma* species with a pale, smooth stipe. We find this to be consistent with the interpretation of *T. atrosquamosum* by several authors in central and northern Europe (e.g. Gulden 1969, Dähncke & Dähncke 1979), and consider *T. atrosquamosum* to be a sister taxon to *T. orirubens*, with weaker colour reactions and a restriction to coniferous forests (Christensen & Heilmann-Clausen 2008). Preferably a neotype should be collected in southern Germany to stabilize the interpretation of this name.

We have found no indication that Elias Fries was familiar with *T. olivaceotinctum*. This probably reflects that the species was lacking or very rare in his collecting grounds around Femsjö and later Uppsala. Even in other classical mycological works from the Nordic countries we have not come across any other taxa matching with the species. Therefore we find it necessary to describe the species as new.

Macroscopically, *T. olivaceotinctum* resembles *T. squarrulosum*, but it is distinguished by differences in ecology and distribution, and by having more slender basidiocarps with distinct olivaceous tinges, especially at the cap margin. Microscopically it is distinguished by having comparably small spores. The species may even be confused with *T. atrosquamosum*, which may occur in quite similar habitats. From this species *T. olivaceotinctum* is best separated based on the distinctly greyish or brown stipe and olivaceous colours at the cap margin. Furthermore, *T. atrosquamosum* is mainly a southern boreal species in Fennoscandia and the zone where these two taxa co-occur is limited.

Key to species resembling *T. olivaceotinctum* in northern Europe:

1. Stem white, ± shiny, sometimes with discrete, scattered blackish scales, often becoming blue-green and/or magenta in basal part after picking; smell sweetish, like honey or of cedar wood (farinaceous when cut) 2
- Stem pale greyish or brownish smooth or with a dense covering of dark scales or fibrils, often becoming reddish in basal part after picking; smell aromatic spicy, like pepper (farinaceous when cut) 3
2. Mycelium yellow; cap felty or scaly, but scales not strongly recurved; with or without strong contrast between scales and exposed flesh; under *Fagus*, *Quercus*, *Tilia* and *Corylus*, (spores 4–7 × 3–5 µm) . . . *T. orirubens*
- Mycelium white; cap with distinct, upright and recurved scales strongly contrasting the white flesh; under conifers, (spores 4–7 × 3–4.5 µm). . . . . *T. atrosquamosum*
3. In herb rich, mossy *Picea* forests, often on damp calcareous or mesotrophic soils; cap with a distinct olivaceous tinge, especially at margin; spores 4–6 × 3–5 µm. . . . . *T. olivaceotinctum*
- In thermophilic deciduous forests, mainly on dry, calcareous soils; cap without a distinct olivaceous tinge; spores on average > 5.5 µm long 4
4. Cap margin whitish woolly in young basidiocarps; flesh only weakly reddening in stem base, (spores 6–8 × 4–5.5 µm) . . . . . *T. squarrulosum*
- Cap margin almost smooth, even in young basidiocarps; flesh strongly reddening in stem base and often in entire basidiocarps after handling, (spores 5–7 × 3.5–5 µm). . . . . *T. basirubens*

Acknowledgements

We are thankful to Gro Gulden (Oslo), Ilkka Kytövuori (Helsinki), Henning Knudsen and Jan Vesterholt (Copenhagen) for important information and valuable discussions of taxonomy and nomenclature in *Tricholoma*. Rasmus Kjøller and Tobias Frøslev (Copenhagen) are thanked for being very helpful with ITS sequencing and alignment of chromatograms. Thanks to Erik Rald and Benjamin Ølgaard for correcting our diagnoses. Thanks to Stig Jacobsson, Tor Erik Brandrud and Shaun Pennycook for their very useful and improving comments during the review process

Literature cited

Bas C, Kuyper T, Noordeloos ME, Vellinga EC. 1988. Flora agaricina neerlandica, vol. 1. Rotterdam, Balkema.

Bon M. 1984. Les Tricholomes de France et d'Europe occidentale. Encycl. Mycol. 36. Paris, Editions Lechevalier.

Bon M. 1991. Flore Mycologique d'Europe, vol. 2, Les Tricholomes et ressemblants. St Valery-sur-Somme.

Bresadola G. 1892. Fungi Tridentini novi vel nondum delineati, descripti et iconibus illustrati 2(8/10), p. 1–46, pl. 106–150. Trento.

Chevalier FF. 1837. Fungorum et Byssorum Illustrationes. Leipzig.

Christensen M, Heilmann-Clausen J. 2008. *Tricholoma* (Fr.) P. Kumm. 413–429, in H Knudsen, J Vesterholt (eds.) Funga Nordica. Copenhagen, Nordsvamp.

Dähncke RM, Dähncke SB. 1979. 700 Pilze in Farbfotos. Stuttgart, AT Verlag Aarau.

Fries E. 1821. Systema Mycologicum. Lund.

Fries E. 1838. Epicrisis Systematis Mycologici seu Synopsis Hymenomycetum,Uppsala.

Fries E. 1874. Hymenomycetes Europaei sive epicriseos systematis mycologici, Editio Altera. Uppsala.

Gärdenfors U. (ed.) 2005. Rödlistade arter i Sveriga 2005. Uppsala, Artdatabanken

Gray SF. 1821. Natural arrangement of British plants. 1. London.

Gulden G. 1969. Musseronflora. 96 pp. Oslo, Universitetsforlaget.

Gulden G. 1992. *Tricholoma* (Fr.) Staude. 183-191, in L Hansen, H Knudsen (eds.) Nordic Macromycetes, vol 2. Copenhagen, Nordsvamp.

Heilmann-Clausen J, Verbeken A, Vesterholt J. 1998. The genus *Lactarius.* Fungi of Northern Europe, vol. 2. Tilst, Danish Mycological Society.

Kålås JA, Viken Å, Bakken T. (eds.) 2006. Norwegian Red List, 2006. Trondheim, Artsdatabanken.

Karsten PA. 1899. Finlands Basidsvampar. Helsingfors.

Kornerup A, Wanscher JH. 1969. Farver i Farver. Copenhagen, Politiken.

Kühner R. 1980. Les Hyménomycetes agaricoides (*Agaricales, Tricholomatales, Pluteales, Russulales*). Etude générale et classification. Bull. Soc. Linn. Lyon 49, numero spécial.

Kühner R, Romagnesi H. 1953. Flora Analytique des Champignons Supérieurs. Paris, Masson & C^{ie}.

Mcneill J, Barrie FR, Burdet HM, Demoulin V, Hawksworth DL, Marhold K, Nicolson DH, Prado J, Silva PC, Skog JE, Wiersema JH, Turland NJ. (eds.) 2006. International Code of Botanical Nomenclature (Vienna code) adopted by the Seventeenth International Botanical Congress Vienna, Austria, July 2005. Regnum Vegetabile, 146.

Noordeloos ME, Christensen M. 1999. *Tricholoma.* 107–148, in C Bas et al. (eds.) Flora Agaricina Neerlandica, vol. 4, Rotterdam, Balkema,

Persoon CH. 1801. Synopsis metodica fungorum, sistens enumerationem omnium hucusque detectarum specierum, cum brevibus descriptionibus nec non synonymis et observationibus selectis. Göttingen..

Riva A. 1988. *Tricholoma* (Fr.) Staude. Fungi Europaei, vol 3. Saronno, Giovanna Biella.

Ryman S, Holmåsen I. 1984. Svampar. Stockholm, Interpublishing.

Salo P, Niemelä T, Nummela-Salo U, Ohenoja E. (eds.) 2005. The ecology, distribution and Red List status of Finnish agarics and boletes. Helsinki, Suomen ympäristö.

Schaeffer JC. 1762. Fungorum qui in Bavaria et Palatinatu circa Ratisbonam nascuntur icones 1. Regensburg.

Schaeffer JC. 1774. Fungorum qui in Bavaria et Palatinatu circa Ratisbonam nascuntur icones 4. Regensburg